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NORTH COASTAL AREA ACTION PROGRAM

A Study of the McKinleyville-Trinidad Area

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FEBRUARY 1969

NORMAN B. LIVERMORE, JR.
Secretary for Resources
The Resources Agency

RONALD REAGAN
Governor
State of California

WILLIAM R. GIANELLI
Director
Department of Water Resources

STATE OF CALIFORNIA

The Resources Agency

Department of Water Resources

BULLETIN No. 105-2

NORTH COASTAL AREA

ACTION PROGRAM

A Study of the McKinleyville-Trinidad Area

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FOREWORD

In 1966 the California Legislature requested the Department of Water Resources to initiate an action program of investigation on the Smith, Mad, Van Duzen, and South Fork Eel Rivers. The first phase of this action program, reported on in Bulletin No. 105-1 in December 1966, selected the coastal strip from Humboldt Bay to Trinidad as having the most pressing need for new water supplies.

As a result, the Department focused the action program on this coastal strip and carried out a 1-1/2 year reconnaissance investigation of the McKinleyville-Trinidad area. This bulletin reports on that investigation.

The objective of the study was to formulate plans for the development of water supplies within the McKinleyville-Trinidad area. It was concluded that the best way to provide additional water supplies to the study area would be through annexation to the Humboldt Bay Municipal Water District and construction of a pipeline from the District's system into the McKinleyville-Trinidad area.

This study was coordinated with the local agencies involved in water development in the area. The Humboldt Bay Municipal Water District, in addition to working closely with the Department, also conducted a complementary study of potential projects on Little River.

William R. Gianelli

William R. Gianelli, Director
Department of Water Resources
The Resources Agency
State of California
January 28, 1969

State of California
The Resources Agency

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RONALD REAGAN, Governor
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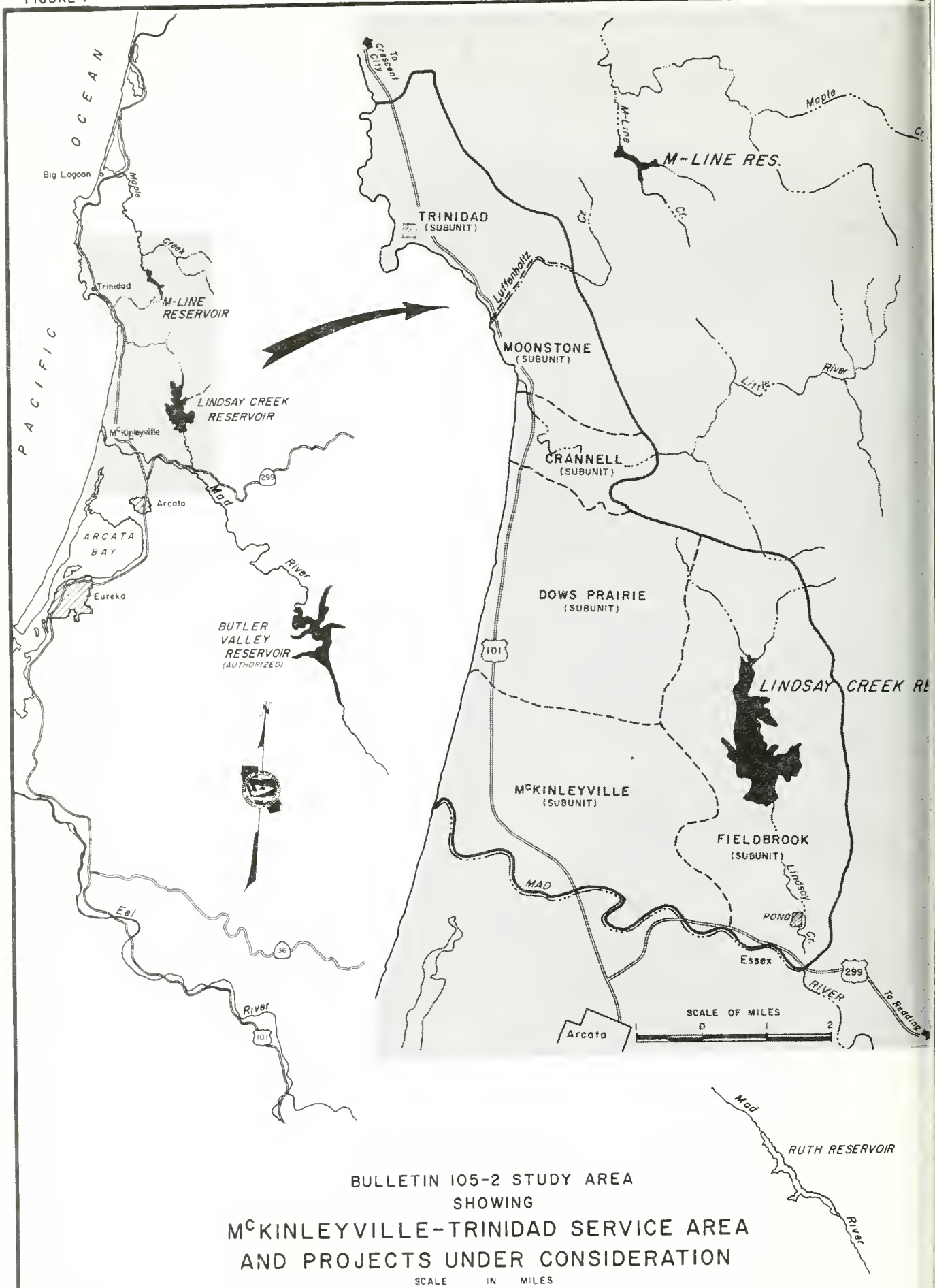
ABSTRACT

The McKinleyville-Trinidad region has experienced periodic summer shortages of water for several years. The area obtains its water supplies from ground water and a few small surface diversions. Severe water shortages in the summer and fall of 1966 prompted county officials to request planning assistance from the Department. This report presents the results of the studies undertaken at that time and concludes that the best way to provide additional water to the McKinleyville-Trinidad area would be through annexation to the Humboldt Bay Municipal Water District (HBMWD) and construction of a pipeline from that district into the McKinleyville-Trinidad area.

The best way to provide long-term future water supplies to the HBMWD would be the construction of the Butler Valley Project on the Mad River. If the HBMWD finds it advisable to construct a project to provide interim water supplies to the district between now and when the Butler Valley Project can be operational, the Lindsay Creek Project, consisting of a dam and reservoir on Lindsay Creek tributary to the Mad River, could be a suitable development to serve this purpose.

In the event the McKinleyville-Dows Prairie area will not annex to HBMWD and the Trinidad-Moonstone area must independently seek new water supplies, there are other possible sources of water for this area. If Luffenholtz Creek proves feasible for a short-term supply, the M-Line Project, consisting of a dam and reservoir on M-Line Creek and a pump diversion system to lift water into the upper Luffenholtz Creek drainage area, would be a suitable later addition to the Luffenholtz Creek diversion.

FIGURE 1



BULLETIN 105-2 STUDY AREA
SHOWING
McKINLEYVILLE-TRINIDAD SERVICE AREA
AND PROJECTS UNDER CONSIDERATION

CHAPTER 1. SUMMARY

During the first extraordinary session of 1966, the California Legislature adopted Assembly Concurrent Resolution No. 27. This resolution requested the Department of Water Resources to initiate an action program of investigation of local water development projects on the Smith, Mad, Van Duzen, and South Fork Eel Rivers. Subsequent budget acts have provided funds to continue this program to study local water problems in the North Coastal area.

The first report on this program was Department of Water Resources' Bulletin No. 105-1, "Developing the North Coast, An Action Program", Progress Report, December 1966. This report presented a preliminary evaluation of local problems throughout the North Coastal area and selected the coastal strip from Humboldt Bay to Trinidad as having the most pressing need for new water supplies.

In January 1967, studies were initiated to identify possible alternative sources of water supply for the McKinleyville-Trinidad area. After appraisal of several possible sources of water supply for the McKinleyville-Trinidad area, the Department concluded that the best solution to the water problems in this area is annexation to Humboldt Bay Municipal Water District (HBMWD). However, two factors caused the Department to continue studies in the area. First, there was a great deal of opposition in the McKinleyville area to any proposal that would obtain water from HBMWD. Rejection of this source by McKinleyville would leave the Trinidad-Moonstone portion of the study area, the region of most severe shortages, with no apparent solution to their problem. Second, HBMWD had expressed the possible need for an interim source of supply until such time that the proposed Butler Valley Project on the Mad River could be constructed. After meetings with local agencies, a joint work program was devised whereby: The Department of Water Resources would study the M-Line Project and the Lindsay Creek Project; the Humboldt Bay Municipal Water District would study potential projects on Little River; and Winzler and Kelly Engineers of Eureka, in addition to providing their normal services to HBMWD, would study possible sources of supply for the city of Trinidad.

This report gives the results of these studies and explains the relationship between our studies and studies conducted by other agencies.

Water Problems in the McKinleyville-Trinidad Area

The McKinleyville-Trinidad region has experienced periodic summer shortages of water for several years. The area obtains its water supplies from ground water and a few small surface diversions. Severe water shortages in the summer and fall of 1966 prompted county officials to request planning assistance from the Department.

Although the McKinleyville-Trinidad area as a whole has an urgent need for increased water supplies, there are many individuals with adequate well systems. Action toward a unified plan has been difficult because of the varying needs within the area. In 1962 voters in the McKinleyville area chose (by a narrow margin) to withdraw from the HBMWD even though they would still be obligated along with the rest of the district for $12,000,000 in bonds. The position of the HBMWD on the matter is expressed in its publication entitled "District Policy on Water Development and Expansion", April 1967. This report expresses the desire of the district to serve future water needs of the McKinleyville-Trinidad area.

The many advantages of unified planning efforts should be seriously considered before an individual subunit elects to "go it alone" in the matter of water development. Planning which satisfies the needs of a large area has the inherent advantage of distributing the cost of a project over a broader economic base, thus generally reducing the cost to each individual. Also, savings can be realized through the increased efficiency of a single planning study, contract award, and maintenance district. Another practical advantage of a unified water plan which considers the needs of as large a group as possible lies in the area of potential financial assistance from government agencies. Such assistance in the form of loans and grants is available to qualified public agencies.

For this study the McKinleyville-Trinidad service area was divided into six subunits as shown in Figure 1. The following sections describe the water problems in these individual subunits or in groupings of subunits.

Trinidad and Moonstone Subunits

The area from Moonstone to Trinidad has very few successful wells and must rely mainly on surface diversions from small creeks for domestic water. This region has probably the most immediate need for new water supplies. The Trinidad city system pumps from behind small dams on Mill and McConnahas Mill Creeks. There is no treatment provided within the existing network although some individual homeowners use small water purification units. Summer water shortages have forced occasional rationing of water.

Crannell Subunit

The town of Crannell, an older logging community owned by Georgia Pacific, served as the Northwest Pacific Railroad's North Coast railhead until recent years. At present many dwellings in the town are unoccupied or in the process of being dismantled. The water system serves users from small dams on Coons Creek and Water Gulch. Although water quality is marginal, the system is considered adequate until the area experiences new growth. Ground water exists but, due to the low elevation, sea water intrusion is a danger.

Dows Prairie and McKinleyville Subunits

In the Dows Prairie and McKinleyville subunits ground water is served primarily from shallow, privately owned domestic wells drawing from the highest of two aquifers. The use of ground water in an area where sewage is commonly disposed of by individual septic tank systems constitutes a definite health hazard where tight controls are not established. Summer shortages occur along the elevated eastern boundary in years of average rainfall and at lower elevations during dry years. Such water shortages hamper the growth of an area and present a fire hazard when adequate flows for protection are not available.

The McKinleyville School, shopping center, and some subdivisions pump from the lower aquifer which provides a dependable source. However, the safe maximum yield from this source is thought to be inadequate to serve the long-range future demand of the McKinleyville-Dows Prairie area. A 1959 report, "Reconnaissance Studies of Lower Klamath and Adjacent Basins, California", by the Bureau of Reclamation, Geology Branch, estimates the safe yield of the ground water basin in the Dows Prairie plateau area to be roughly 2,500 acre-feet per year.

Fieldbrook Subunit

The Lindsay Creek Valley relies on ground water for domestic use and stream diversion for irrigation. The wells are of low yield due to fine grained and compact subsurface soils. The limited ground water supply constitutes a retarding influence on the growth of the area.

Possible Source of Future Water Supplies

During the course of this investigation, several potential water sources were considered and two projects were evaluated on a reconnaissance level. All sources considered are discussed generally here with a more detailed treatment of the two projects following in later chapters.

Service from Humboldt Bay Municipal Water District

The HBMWD could provide water for all of the McKinleyville-Trinidad area. Such service would require construction of a 12-mile main transmission line to Trinidad from a point on the existing system near Janes School on Alliance Road.

The HBMWD presently estimates that 4,000,000 gallons per day (gpd) peak flow is available to the area. There would be an annual charge of $19,108 per million gallons peak daily delivery. This charge is for filtered water at an elevation of approximately 235 feet and assumes that the area would tie into the HBMWD line just north of Arcata and that the combined cost of the main transmission pipeline and secondary distribution

system to individual lots within the area served would be an obligation of this area. This charge also assumes that the average annual daily water use would not exceed 66 percent of the peak daily use. If water is contracted for under these conditions and the contracted amount is actually used, the unit water cost would be approximately $25.85 per acre-foot. Assuming a peak daily use of 2-1/2 times the average daily use, this 4,000,000 gpd peak supply would provide about 1800 acre-feet of water annually. This would supply the water requirements of the entire area until about 1985. It is assumed that previous to this time HBMWD would develop another source of supply (i.e., the Butler Valley Project) and the long-term future water requirements of the area would be assured.

Ground Water

Development of ground water to serve the domestic needs of the Dows Prairie plateau between the Mad River and Little River floodplains through about 1980 is a possibility. The Bureau of Reclamation in its study of the Lower Klamath and adjacent basins estimates the potential safe yield of the Dows Prairie plateau area at approximately 2,500 acre-feet per year.

Septic tank and sewer drainage threatens the water supplies of this area because wells so often lie adjacent to sewage drain fields.

The potential of ground water supply in the remainder of the study area is very limited. From Moonstone through Trinidad very few successful wells are in operation. Likewise, in the community of Fieldbrook most of the wells are low producing and a few dry up during the summer.

A comprehensive ground water study necessary to reliably evaluate this source of supply was beyond the scope of this investigation. Therefore, no attempt was made to include ground water in the evaluation of possible supplies.

Potential Reservoir Projects

The three major stream drainages within the study area are Maple Creek, Little River, and Lindsay Creek, each exhibiting a potential for new water supply development. Five potential developments in these drainages were chosen for comparative study and were designed to yield the water necessary to satisfy the projected 50-year demands of the entire McKinleyville-Trinidad area. In addition to these five developments, two reservoirs, one on Luffenholtz Creek and one on M-Line Creek, were studied for limited water supply to the Trinidad-Moonstone area. Of these seven reservoirs, two were chosen for further study and are presented in Chapters 3 and 4. The remaining projects are described in Chapter 5.

Conclusions

1. The best way to provide additional water supplies to the Mckinleyville-Trinidad area would be through annexation to the Humboldt Bay Municipal Water District and construction of a pipeline from HBMWD into the McKinleyville-Trinidad area.

2. The U. S. Army Corps of Engineers in its recent studies of the Mad River Basin has determined that the best long-term way to provide future water supplies to the HBMWD would be the construction of the now authorized Butler Valley Project on the Mad River.

3. The Lindsay Creek Project -- consisting of a dam and reservoir on Lindsay Creek, tributary to the Mad River -- could provide a safe annual yield of 26,000 acre-feet to the HBMWD and would be an excellent recreation project. The project would have a gross storage capacity of 17,700 acre-feet, a normal water surface area of 620 acres, and an investment cost of $12,400,000. If constructed in 1975, it would have a benefit-cost ratio of 1.3:1.

4. In the event the McKinleyville area does not annex to HBMWD, the Trinidad-Moonstone area must independently seek new water supplies. Two local water sources are available to this area: Luffenholtz Creek and M-Line Creek. A diversion of natural flows from Luffenholtz Creek near its mouth could provide a short-term (10 to 20 years) water supply. The M-Line Creek Project could serve as either a later, staged, supplementary supply to a Luffenholtz Creek diversion or an independent long-term (50 years) water supply.

5. The M-Line Project -- consisting of a dam and reservoir on M-Line Creek and a pump diversion system to lift water into the upper Luffenholtz Creek drainage area -- could provide a safe annual yield of 1100 acre-feet to the Trinidad-Moonstone area. This yield would meet the expected water needs of the area until the year 2020. The single-purpose water supply project would have a reservoir with a gross storage capacity of 780 acre-feet, and a normal water surface area of 33 acres. The investment cost of the project would be $1,500,000, not including a distribution system.

Recommendations

It is recommended that:

1. The McKinleyville-Trinidad area annex to the Humboldt Bay Municipal Water District.

2. Humboldt County and the Humboldt Bay Municipal Water District maintain an active involvement throughout the funding, final planning, construction, and operation phases of the Butler Valley Project.

3. If the HBMWD finds it advisable to construct a smaller-scale project to provide a limited water supply, the District should consider the Lindsay Creek Project which could fulfill its demands for a 10- to 15-year period.

4. If the Trinidad-Moonstone area finds it necessary to seek a water supply, other than HBMWD, a diversion from Luffenholtz Creek or a dam on M-Line Creek should be considered. If a diversion from Luffenholtz Creek is selected as the initial development, then the M-Line Project should be considered as a possible future addition and provisions made in the initial development to incorporate this future addition.

CHAPTER 2. AREA OF INVESTIGATION

The McKinleyville-Trinidad area is a small coastal plain in Humboldt County, approximately 9 miles long, tapering in width from about $2\frac{1}{2}$ miles near the Mad River to less than $\frac{1}{2}$ mile at Trinidad. The coastal portion of the area is characterized by elevated terraces 50 to 300 feet above sea level, sliced by westward flowing streams. Grassy fields are interspersed with thickly wooded forest lands which support a varied growth from eucalyptus and cypress to sizable redwoods. Inland just beyond the first low range of coastal hills lies the Lindsay Creek Valley. This valley is protected somewhat from the coastal wind and fog, and is warmer than the coast. Ground cover in the valley is abundant and varied.

The area has a moderate climate with little seasonal variation in temperature and considerable fog and rain. Seasonal rainfall varies from about 40 inches near the mouth of the Mad River up to 80 inches in the eastern mountainous areas at the head of the Little River drainage.

Several streams flow through or are adjacent to the study area. Such streams which at present are completely uncontrolled include Little River, Lindsay Creek, and Luffenholtz Creek. McConnahas Mill and Mill Creeks near Trinidad are partially diverted by low dams to serve as domestic water supply. The Mad River forms the southern McKinleyville area boundary.

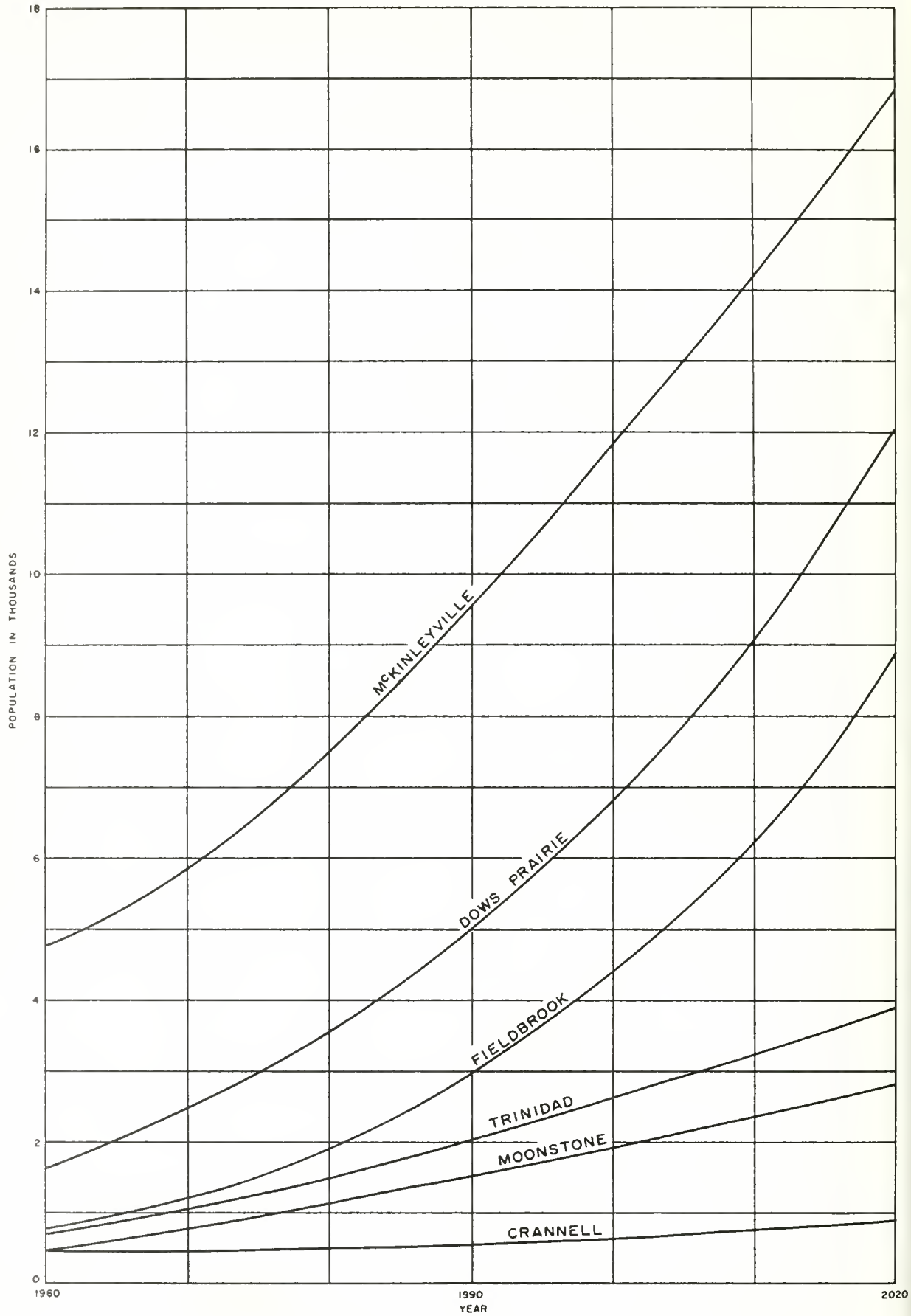
Development

The southern half of the service area (McKinleyville-Dows Prairie) has experienced considerable growth since the war years. Future development is expected to rise steadily. In most instances, the study area growth has not been paralleled by a corresponding increase in community services such as water and sewage.

Larger communities in the area include McKinleyville, Fieldbrook, Dows Prairie, Moonstone, and Trinidad. Trinidad is the only incorporated city in the area and the second oldest incorporated city in California. Founded in 1852 during the gold mining days along the Trinity River, the town boomed and at one time numbered several thousand people. The McKinleyville-Dows Prairie plateau was settled in the early 1860's and has since grown to a population of approximately 8,000.

The flatter areas near the coastline constitute most of the developed region within the study area. This development decreases in density as the land slopes upward toward the first small range of coastal mountains to the east. The community of Fieldbrook, just beyond this range, includes several ranches and a spotty development of homesites.

FIGURE 2



PROJECTED STUDY AREA POPULATION

Industrial development within the study area, except for agriculture, is almost totally lacking. Assorted crops, poultry, dairy cattle, and a small lily bulb industry account for most of the agriculture. However, the recent opening of several new businesses in McKinleyville is evidence of the growth of commerce in this community. The McKinleyville-Trinidad region is essentially a residential area with the majority of its residents working outside the boundaries of the area. Small businesses and schools provide the bulk of employment within the area.

The main artery of transportation through the area is the Redwood Highway, U. S. 101, which parallels the coast. State Route 299 connects with the Redwood Highway just south of the Mad River. Public access to Fieldbrook is now limited to one dead-end road from State Route 299. A direct route from McKinleyville to Fieldbrook is in the planning stage. Rail and deep water harbor facilities are available at Eureka and air service at the Eureka-Arcata Airport. The airport serves a relatively large segment of the Humboldt County population yearly and does a considerable business in air freight.

Tourism has contributed to the economy of the McKinleyville-Trinidad area and should continue to do so in the future. This region is centrally located amidst a variety of existing and potential recreational areas. Trinidad Bay and offshore waters offer a popular salmon fishing area while Trinidad Beach State Park with 11,000 feet of ocean frontage presents visitors with a site for picknicking, fishing, abalone hunting, skin diving, or just pausing to enjoy the serenity of the ocean view. South of Trinidad, various county- and state-owned beaches are open for public recreation use. Patrick's Point State Park lies approximately 6 miles north of Trinidad on U. S. 101. This rocky seacoast area, noted for its famous agate beach, is a type "A" park of 425 acres with family campsites.

Except along the Mad River, freshwater recreational activities are almost nonexistent in the McKinleyville-Trinidad area. A small reservoir such as the Lindsay Creek Project could serve a portion of the freshwater recreation demand of the study area.

Surface Water Supply

There is an abundance of natural runoff from streams in and adjacent to the study area. However, due to the relatively low elevations of these drainage areas, most precipitation occurs as rainfall and there is very little snowpack to feed summer runoff. The seasonal variation in rainfall reduces summer runoff to a trickle in many streams of this area. Annual precipitation at Crannell ranges from 30 inches to 78 inches.

The two existing reservoirs within the study area are located on Mill and McConnahas Mill Creeks and presently supply water to the City of Trinidad. These reservoirs are extremely small and have proved insufficient to meet summer demands in the past.

The only stream gaging station within the study area is on Little River at Crannell. Flows of the Mad River are measured near Essex on the south study area boundary. All flows at proposed damsites within the study

area are estimated by an area-precipitation relationship using flows recorded at the Crannell gage. Mean annual runoff at the Crannell gage is 93,600 acre-feet from a drainage area of 40.3 square miles. Table 1 gives the drainage area and estimated surface water runoff at the damsites considered. These damsites are shown in Figure 12.

TABLE 1

DRAINAGE AREAS AND ESTIMATED MEAN ANNUAL RUNOFF AT DAMSITES

Damsite	Drainage Area (sq. miles)	Mean Annual Runoff (acre-feet)
Lindsay Creek	10.4	18,750
Crannell	39.8	92,500
Tip Top	28.4	70,000
Luffenholtz Creek	2.4	5,100
M-Line	2.75	5,800
Maple 8	19.5	53,000
Maple 9	17.9	43,000

Water Requirements

Future water requirements in the McKinleyville-Trinidad study area are expected to be mainly domestic and commercial in nature. Very little new industrial water use and a decreasing volume of agricultural water use due to urban encroachment on farmland is the predicted future trend. Therefore, future water use in the service area subunits will be contingent upon population growth. Population projections and estimated annual water requirements for each of the service area subunits are presented in Table 2. The total urban population in the study area increased from about 3,300 people in 1950 to about 8,820 in 1960, or a gain of 167 percent compared to a gain of 52 percent in the total county population. This disproportionate rate of gain is projected as decreasing until by the year 2020 the McKinleyville-Trinidad growth rate is expected to be the same as the county's growth rate.

The present water requirement for the southern portion of the study area was estimated at 115 gallons per person per day. Field interviews indicate that the Moonstone and Crannell areas use about 110 gallons per capita per day and that the Trinidad area uses about 100 gallons per capita

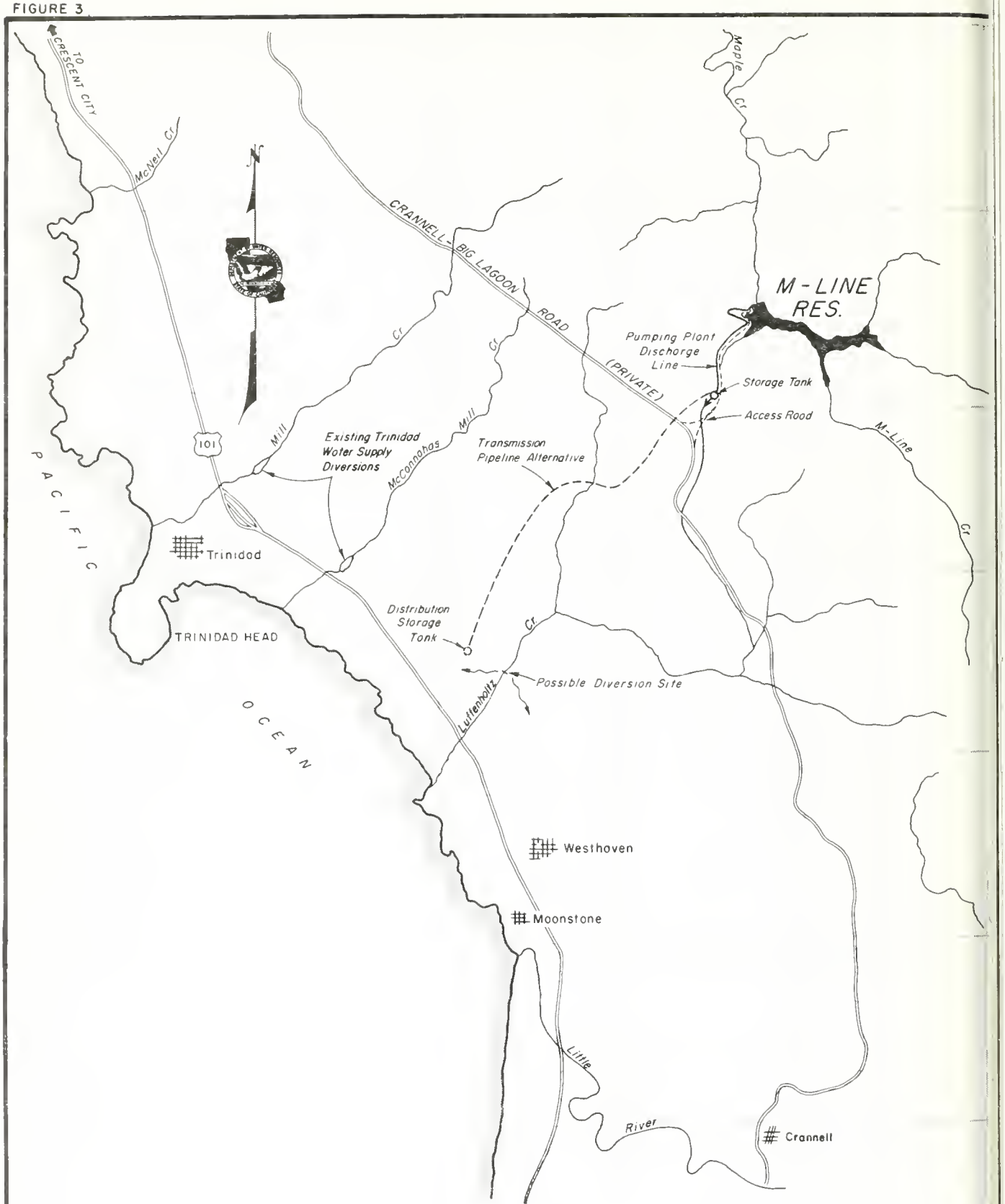
per day primarily due to a limited water supply. With an adequate water supply, the per capita water requirement is expected to increase to 130 gallons per day by 1990 and 150 gallons per day by 2020.

TABLE 2

SERVICE AREA POPULATION AND
MUNICIPAL WATER REQUIREMENTS

Service Area Subunits	1960 Population	1960 Avg. Water Requirements AF/Yr.	1990 Population	1990 Avg. Water Requirements AF/Yr.	2020 Population	2020 Avg. Water Requirements AF/Yr.
Trinidad	718	80	2,050	300	3,900	570
Moonstone	442	55	1,550	230	2,800	470
Crannell	450	55	600	90	900	150
Dows Prairie	1,612	210	5,050	740	12,050	2,020
McKinleyville	4,806	620	9,550	1,390	16,750	2,810
Fieldbrook	795	100	2,950	430	8,850	1,490
TOTAL	8,823	1,120	21,750	3,180	45,250	7,510

FIGURE 3



M-LINE PROJECT
LOCATION MAP

SCALE OF FEET
1000 0 1000 3000 5000

CHAPTER 3. THE M-LINE PROJECT

The Trinidad-Moonstone area has an immediate need for increased water supplies and is seeking a solution to this pressing problem. Three small streams, Mill, McConnahas Mill, and Luffenholtz Creeks, flow through this area in a southwesterly direction. Two of these, Mill and McConnahas Mill Creeks, are presently dammed by small structures and provide the existing water supply to Trinidad. These reservoirs are too small to adequately meet the late summer and early fall demands during many years and water rationing is sometimes required. The third stream, Luffenholtz Creek, is undeveloped at present.

Several proposals for the solution of this area's water shortage have been advanced by government agencies and individuals concerned. The most desirable alternative in many respects is the proposed pipeline from HBMWD serving all areas from McKinleyville to Trinidad. However, objections to such a plan from those in the McKinleyville-Dows Prairie area who presently have adequate water or favor another alternative make it imperative that Trinidad-Moonstone evaluate other independent sources. A study of Luffenholtz Creek as a near-future source of water is presently being conducted for the city of Trinidad by Winzler and Kelly, consulting engineers of Eureka.

The M-Line Project on M-Line Creek, a tributary of Maple Creek (see Figure 3), is a third proposal which appeared in early reconnaissance studies as a good potential long-term future source to the Trinidad-Moonstone area. This project could also serve as a suitable future addition to a Luffenholtz Creek Project.

Hydrology

The Maple Creek drainage is not monitored by a stream gaging station; therefore, it was necessary to derive synthetic flows for M-Line Creek by an area-precipitation correlation with Little River, which has a stream gaging station at Crannell. Through this procedure M-Line Creek at the proposed damsite is estimated to have an average annual runoff of 5,800 acre-feet. Runoff would range from a late summer trickle of less than 1 cfs to steady midwinter flows of more than 20 cfs. An estimated peak discharge of 3,500 cfs per square mile of drainage area was used to determine a peak spillway design discharge of 10,000 cfs.

Water Quality

The water of M-Line Creek, sampled in March 1968, exhibited good mineral quality except for excessive iron concentrations of approximately

0.5 part per million. This condition is common to most streams in the McKinleyville-Trinidad region. The U. S. Public Health Service drinking water standards contain a recommended limit of 0.3 ppm for iron. The presence of iron in domestic waters is undesirable because it stains plumbing fixtures and has an undesirable odor and taste. Treatment for the removal of iron should be provided in the water system along with standard chlorination and filtration. Biological contamination in the M-Line Creek drainage is not considered a problem due to the uninhabited nature of the drainage basin. Reservoir-associated recreation should be restricted to nonwater-contact activities, such as fishing and nonpower-boating, in order to preserve the acceptable water quality of the reservoir.

Geology

The regional geology of the M-Line Creek Dam and Reservoir area is shown on the Weed geologic sheet, published by the California Division of Mines and Geology, which indicates that the area is underlain by precretaceous metasedimentary formations. Field examination revealed this formation to be mostly gray to brown metamorphosed sandstones, striking approximately north-south and dipping generally to the east. A memorandum report describing the geologic studies conducted at this site is on file with the Northern District of the Department of Water Resources.

The damsite has uniform, heavily vegetated 40-degree slopes and a narrow channel overlain with recent alluvial deposits. Rock is heavily jointed where it is exposed through the mantle cover, indicating the possible necessity of an extensive foundation grouting program. It was estimated that 14 feet of stripping would be needed to reach a solid base material. Impervious material and quarry rock are available near the damsite. Pervious materials for drains and aggregate will probably have to be secured from the Mad River near Arcata, about 12 miles to the south.

From the limited observations made which included a field and seismic survey, the foundation appears sufficiently strong to support a dam of the proposed height with no major difficulties.

Project Features - Designs and Costs

The M-Line Project as proposed would consist of the following features: (1) dam and spillway, (2) reservoir, and (3) intake structure, pump, and pipeline to transport 2 cfs through a saddle into the upper Luffenholtz Creek drainage. Statistics on the project features are presented in Table 3. A more detailed description of the design and cost estimate is available in a memorandum report on file with the Northern District of the Department of Water Resources.

TABLE 3

M-LINE PROJECT FEATURES

PRIMARY PROJECT PURPOSE

Local domestic water supply for the Trinidad-Moonstone area

M-LINE RESERVOIR

Drainage area, in square miles	2.75
Maximum water surface elevation, in feet	595
Normal water surface elevation, in feet	575
Minimum pool elevation, in feet	562
Capacity, at normal pool elevation, in acre-feet	780
Area of water surface at normal pool, in acres	33
Mapping	Department of Water Resources 1" = 600'

DAM

Location	Section 17, T8N, R1E, HB&M
Type	Earth-rock
Height above streambed, in feet	95
Crest elevation, in feet	600
Volume of fill, in cubic yards	157,000

SPILLWAY

Type	Ungated chute
Design capacity, in cubic feet per second	10,000
Elevation of weir crest, in feet	575
Length of weir crest, in feet	30

OUTLET WORKS

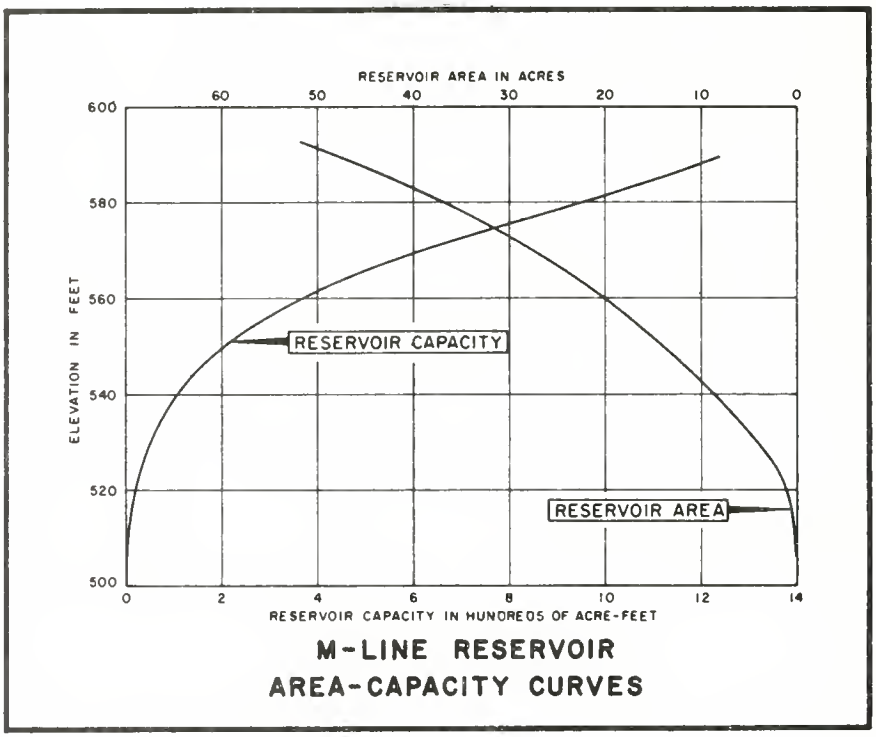
Conduit type	24" cut-and-cover
Control type	Gate valve
Design capacity, in cubic feet per second	10

M-Line Reservoir

The reservoir would have a gross storage of 780 acre-feet at a normal water surface elevation of 575 feet, covering an area of 33 acres. A silt storage of 300 acre-feet is included in the gross storage. Total land acquisition necessary to include a 300-foot setback from a maximum water surface elevation of 595 feet would be 160 acres. The M-Line Creek drainage is owned by Georgia Pacific Corporation.

The reservoir would require clearing of the total 33 acres under normal water surface. About a mile of gravel access road to the dam would be constructed from the Big Lagoon-Crannell logging road. The relationship of reservoir area and storage capacity with water surface elevation is shown in Figure 4.

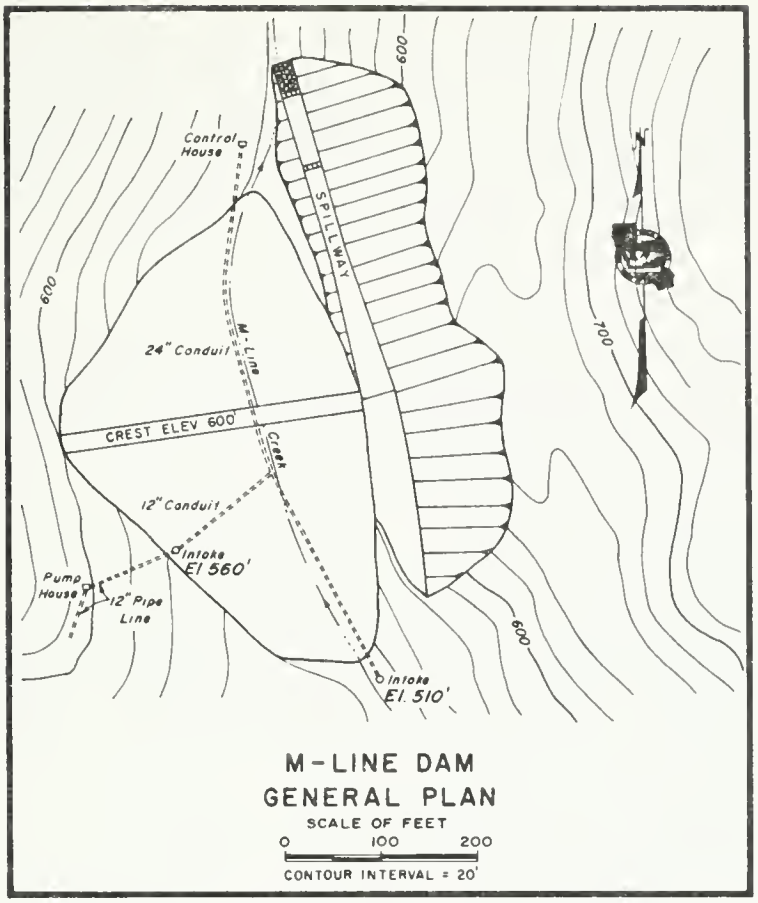
FIGURE 4



Dam

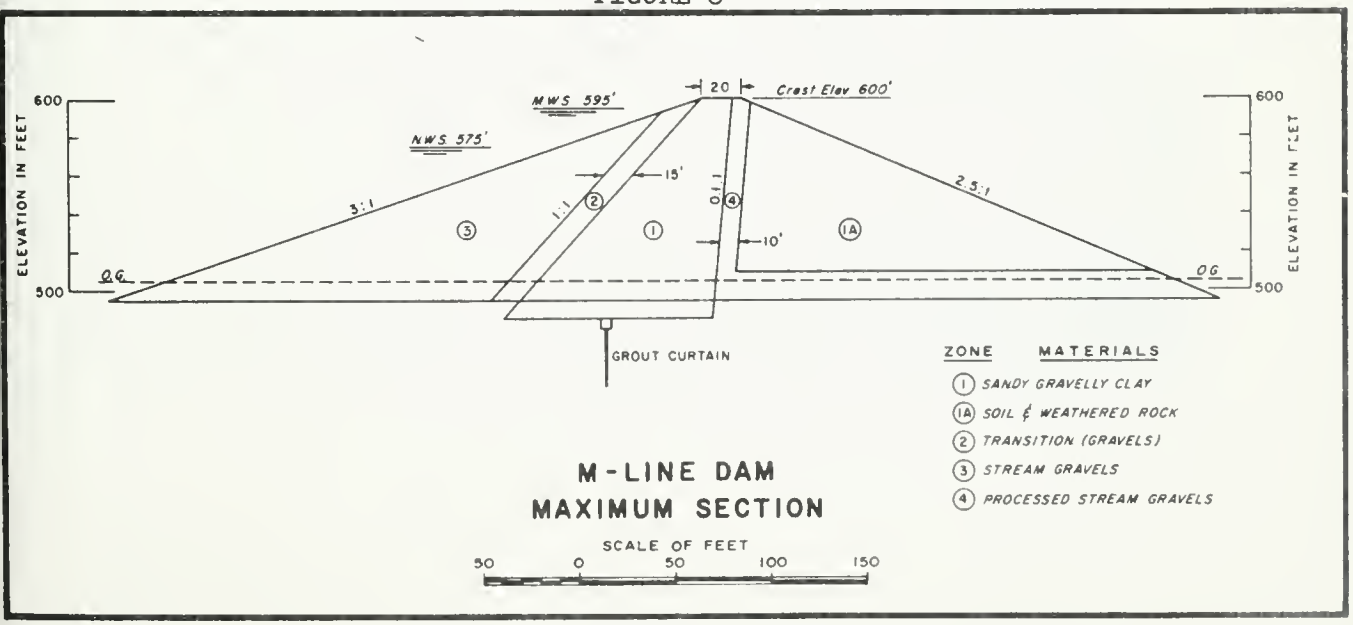
The dam would consist of an earth-rock embankment 95 feet high, containing approximately 157,000 cubic yards of fill material. The crest at elevation 600 feet would have a width of 20 feet and a length of 320 feet. A plan view of the dam is shown in Figure 5.

FIGURE 5



The dam would be a zoned embankment comprised of a centrally located impervious core, an upstream gravel shell on a 3:1 slope, and a downstream random fill shell on a 2.5:1 slope. The dam section would have a 20-foot crest width spreading to a base width of 580 feet. Figure 6 shows the maximum dam section.

FIGURE 6



Spillway

A concrete-lined chute spillway would be located on the right abutment. The headworks would consist of a 30-foot-long uncontrolled weir at elevation 575 feet. The spillway chute would be a transition section narrowing down and terminating at a stilling basin some 300 feet downstream from the weir. The spillway was designed to pass an estimated peak floodflow of 10,000 cfs with a 20-foot surcharge.

Outlet Works

The outlet works would consist of high (elevation 560) and low-level (elevation 510) intake structures designed to pass downstream releases of 10 cfs and evacuate the reservoir in about 10 days if necessary. The main section of the outlet works would consist of a low-level intake structure and concrete encased 24-inch steel pipe located beneath the embankment. A high-level intake is necessary due to the expected silt buildup which could eventually plug a low-level intake. The low-level outlet could possibly be maintained operative throughout the life of the project if surplus flushing flows that would otherwise spill are allowed to pass through this outlet. The intake for the pump diversion facilities to the saddle ridge southwest of the dam is located in the upper level outlet works.

Pumping Facilities

A system capable of delivering an initial maximum flow of 2 cfs to a saddle some 3,500 feet southwest of M-Line Dam would be necessary to serve the Trinidad-Moonstone area. A pumping plant using a 25-horsepower centrifugal pump would be located along the west shore near the dam and would draw from the upper intake structure. The total pumping head would range between 77 and 90 feet.

Recreation Facilities

M-Line Reservoir is not large enough and does not have suitable surrounding lands to support large multiple recreation usage. Since recreation will not play a significant role in project economics, no recreation costs or benefits are included in our analysis. However, if further studies are conducted for this project, some fishing use should be anticipated and provided for. A small boat launching ramp could easily be constructed where the existing trail into M-Line Creek drops to the streambed just above the damsite. A gravel road with a parking area near the Big Lagoon-Crannell road would be adequate to serve initial use. Due to its small size and its primary use as a domestic water supply, the lake should be restricted to small fishing boats and non-water contact use.

Fish and Wildlife Preservation

M-Line Dam will not block anadromous fish because it is located above a series of natural rock and log barriers. Releases from the reservoir will provide a 0.25 cfs minimum year-round flow, which is adequate to maintain the small population of resident trout in the half-mile reach from Maple Creek to the damsite. The reservoir, if stocked annually, could provide good trout fishing. Any fisheries enhancement benefits would be contingent upon safe and ensured public access.

The M-Line Reservoir site supports approximately 100 deer-days of use and is used by songbirds, fur-bearing animals, and other forms of wildlife. This present amount of wildlife use in the proposed reservoir area is considered small and the benefits from the reservoir will compensate for any detrimental effects upon wildlife.

Transmission and Distribution System

Water from M-Line Reservoir must be conveyed approximately 3 miles to the service area. Two alternative schemes were considered to accomplish this purpose. The water pumped to the saddle near the Crannell-Big Lagoon road can be released at this point to flow into the Luffenholtz Creek drainage. It could be diverted from Luffenholtz Creek at a point just upstream from the county road and pumped to water tanks above Moonstone and Trinidad. This plan would expend the gravity-flow potential that the water would have at the 600-foot saddle ridge but would have the advantage of utilizing the natural channel of Luffenholtz Creek. The second alternative would consist of a 12-inch pipeline, running from the saddle to a large storage tank somewhere between Moonstone and Trinidad, serving both areas. Gravity flow would carry the water into the storage facility but the cost of the 2-mile pipeline would tend to offset this advantage. Only detailed engineering analysis of conditions existing near the time of proposed construction can determine the most desirable method of transmission.

An improved and enlarged distribution system connecting the majority of homes in the Trinidad-Moonstone area to a local water storage tank must be constructed as part of any area-wide water system. The capital cost of such a system, including a chlorination and filtration plant, is estimated at approximately $1,100,000 by Winzler and Kelly in their preliminary water system study of the Trinidad-Moonstone area.

Summary of Project Costs

A summary of estimated costs for the M-Line Project is presented in Table 4. These estimated costs are based on an interest rate of 4 percent and a 50-year period of analysis (1970-2020), and represent the amount which must be repayed by the water user. M-Line is a single-purpose water supply project and all costs would be allocated to that purpose.

TABLE 4

SUMMARY OF M-LINE PROJECT COSTS
(in dollars)

Project Feature	Investment Cost	Operation, Maintenance, Replacement, and General Expense 1/	Total Capitalized Cost	Average Annual Equivalent Cost
Dam, Reservoir, and Appurtenances	1,500,000	90,000	1,590,000	74,000
Distribution System	1,100,000 2/	600,000	1,700,000	79,000
Total	2,600,000	690,000	3,290,000	153,000

1/ Includes present worth value of future additions and expenditures.
2/ Adapted from report by Winzler and Kelly, consulting engineers.

Project Accomplishments

The M-Line Project would provide a domestic water supply to the Trinidad-Moonstone area through the year 2020. M-Line Reservoir could yield 1,100 acre-feet annually and would be operated solely for water supply. The minimum release made down M-Line Creek would be a flow of approximately 0.25 cfs to keep a live stream above the confluence with Maple Creek. The reservoir would fill and spill every year.

A benefit-cost ratio was not computed for the M-Line Project. If further consideration is given to this project, benefits must be determined through an analysis of vendibility. This determination was beyond the scope of this study. The real questions in determining the feasibility of this project are: How much will the water cost and are the water users willing to pay this cost? If the users are willing to pay this cost and can find a means of financing the construction of the project, then the project is feasible. The following paragraphs discuss the probable approximate monthly charges for water from the M-Line Project. The real test of feasibility, willingness to pay, must come after detailed studies have more closely defined the monthly charges.

The average monthly water charge to the customer was estimated at $11.65 per household or approximately $300 per acre-foot, assuming a 4 percent interest rate with repayment made over a 50-year period. A second alternative available to public agencies unable to obtain financing on reasonable terms from other sources is state assistance under the Davis-Grunsky Act. The loan terms presently available under this program include an interest rate of 2-1/2 percent and a maximum amortization period

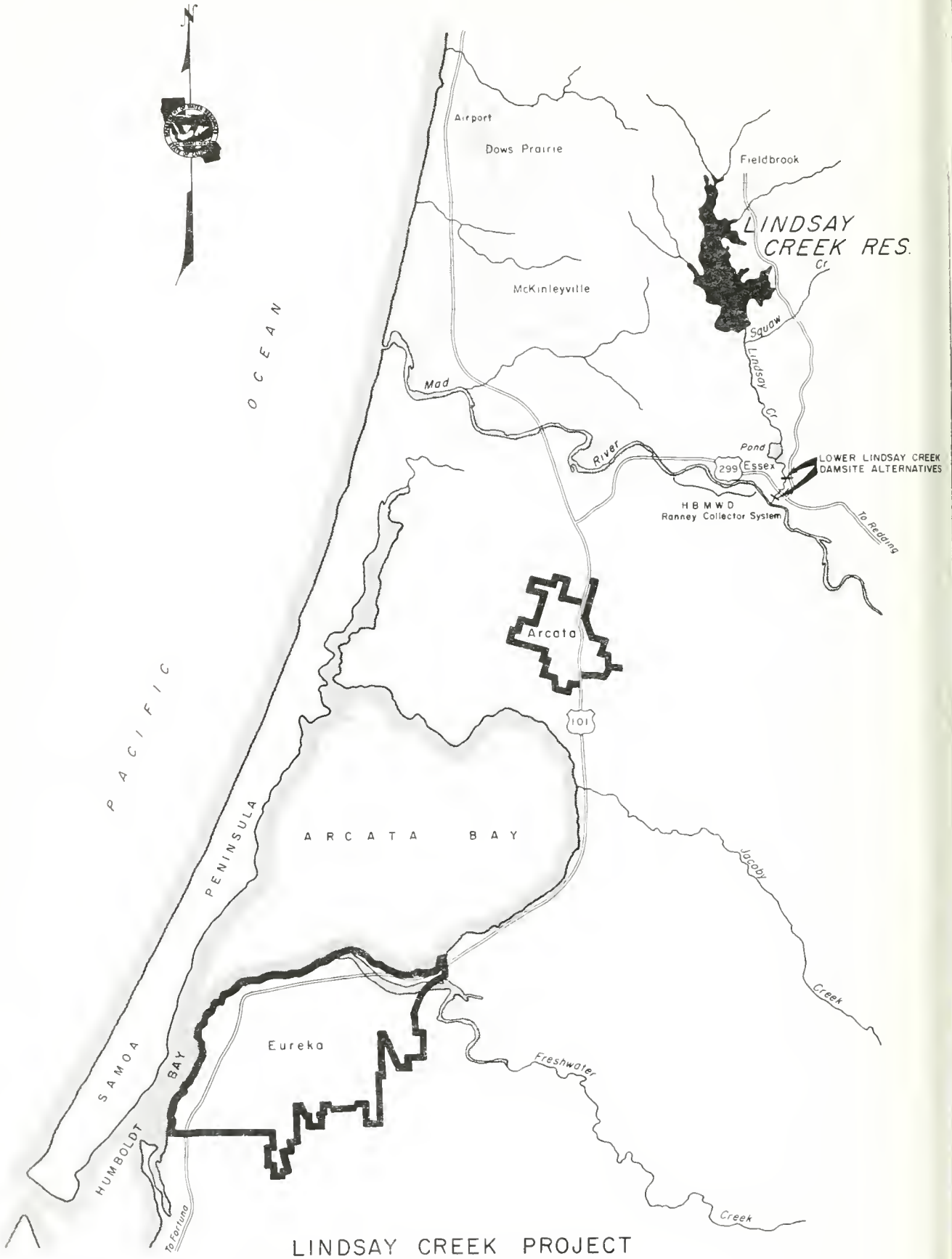
of 60 years with the option to defer payment for the first 10 years. Under these terms the approximate average monthly water charge to the customer would be $9.00 per household or $240 per acre-foot. These monthly charges are within the upper limits of charges that are presently paid in some Northern California communities.

Possible Alternatives

It is possible that other less expensive alternatives to the M-Line Project will become available to serve the water supply needs of the Trinidad-Moonstone area. If the McKinleyville-Dows Prairie region elects to obtain future water supplies from HBMWD by way of a pipeline from North Arcata, an extension of this line could also serve the Trinidad-Moonstone area. HBMWD has recently expressed willingness and ability to market water to the entire McKinleyville-Trinidad area.

Another potential source of water to the Trinidad-Moonstone area could be a direct diversion of natural flows from Luffenholtz Creek at a point near the county road crossing. From the results of a 3-month stream-flow measurement program on Luffenholtz Creek following a relatively dry winter, it appears that this small stream does offer a limited potential for future water supply. The data collected during the 1968 summer and fall season indicates sufficient natural flows to serve the projected water needs of the Trinidad-Moonstone area through approximately 1990, assuming that the 1968 summer flows are indicative of the extreme low flows to be expected in this stream. Future monitoring of the flows in Luffen-holtz Creek will be necessary to reliably establish its true water supply potential.

FIGURE 7



LINDSAY CREEK PROJECT
LOCATION MAP

SCALE OF MILES
1 0 1 2 3

CHAPTER 4. THE LINDSAY CREEK PROJECT

The Lindsay Creek Project (see Figure 7), located in Humboldt County just northeast of Arcata, would consist of a dam and reservoir on Lindsay Creek and water-associated recreation facilities. The project would be operated conjunctively with the existing Ruth Reservoir on the Mad River to provide an additional firm water supply to the HBMWD and to provide for recreational opportunities at Lindsay Creek Reservoir. The project has been evaluated here as a possible source of interim water supply to the HBMWD to serve the demand buildup between now and the time when the Butler Valley Project would be operational.

Hydrology

The Lindsay Creek drainage with eastern ridge peaks of only 2000 feet collects little or no snow during the winter season. Thus runoff is highly responsive to the rainfall pattern and summer flow is entirely dependent upon ground water releases. Precipitation in the drainage area averages 58 inches annually, varying from 50 inches along the low western ridge to 65 inches along Tip Top Ridge to the east.

Monthly and annual flows of Lindsay Creek, which has no gaging station, had to be estimated by correlation with Little River flows recorded at the Crannell gaging station. The total Lindsay Creek drainage basin area is 17.3 square miles and has an estimated average annual runoff of 29,600 acre-feet. The drainage area above the proposed damsite is 10.4 square miles and the estimated average annual runoff at the damsite is 18,750 acre-feet.

Water Quality

Lindsay Creek water sampled from March through May of 1968 was excellent in chemical and mineral quality except for excessive iron concentrations. Turbidity measurements taken during periods of high flows show relatively low turbidity values. Because of the lush vegetation that covers the Lindsay Creek watershed, it is unlikely that inorganic turbidity will be a problem within the reservoir. However, extensive logging activity in the northern watershed area could cause future turbidity problems.

An impoundment in the Lindsay Creek drainage could become infected with undesirable aquatic growth along the shoreline. This possibility exists because of the expected clarity of the water and the rich organic soils in the reservoir.

Because of the development in the Lindsay Creek drainage, there is the possibility of sewage effluent migrating to the surface water of

Lindsay Creek. A number of samples were collected at points along the creek and analyzed for coliform bacteria. The analysis showed that if sewage effluent is migrating to Lindsay Creek, it is being diluted to the point that it is undetectable. If an adequate sewage system is provided around Lindsay Creek Reservoir, it is expected that very little contamination of the water would result from water-contact recreation.

The existing treatment of water by HBMWD is thought to be adequate for purification of water supply releases from Lindsay Creek Reservoir.

Geology

Geology information compiled for this study includes: (1) a California Division of Mines and Geology map of California, Redding Sheet, (2) drill sample test results from drilling along the State Route 299 alignment, supplied by the Division of Highways, (3) a seismic survey run by the Department of Water Resources at Lindsay Creek Dam site, (4) well logs, and (5) a surface geology reconnaissance survey and hand auger samples taken by department personnel.

Lindsay Creek flows through an alluvium-filled valley surrounded by older rocks of the Franciscan Formation. Terrace deposits consisting of fairly consolidated, weak materials form the benchlike topography of the eastern valley. Western slopes are likely Franciscan Formation sandstone. Topographic and seismic survey data suggests that a projection of the Crawford and Korbel fault system passes through Lindsay Creek Dam site near the toe of the left abutment.

A highly compressible blue silty clay is present in the damsite channel area beginning 7 to 8 feet below the surface. Without a drilling program the depth of this layer of material cannot be determined. The strength of this type of material is very poor and extreme settlement could occur with loading. As a result, the design of a dam that can safely be supported by such materials must include costly features to reduce the rate and magnitude of foundation loading. A memorandum report describing the geologic studies made at this site is on file in the Northern District office of the Department of Water Resources.

Project Features - Designs and Costs

The following paragraphs describe the features of the Lindsay Creek Project and summarize the project costs. A more detailed description of the design and cost estimate is available in a memorandum report on file in the Northern District office of the Department of Water Resources. The project layout is shown in Figure 8 and statistics for the project features are presented in Table 5.

FIGURE 8

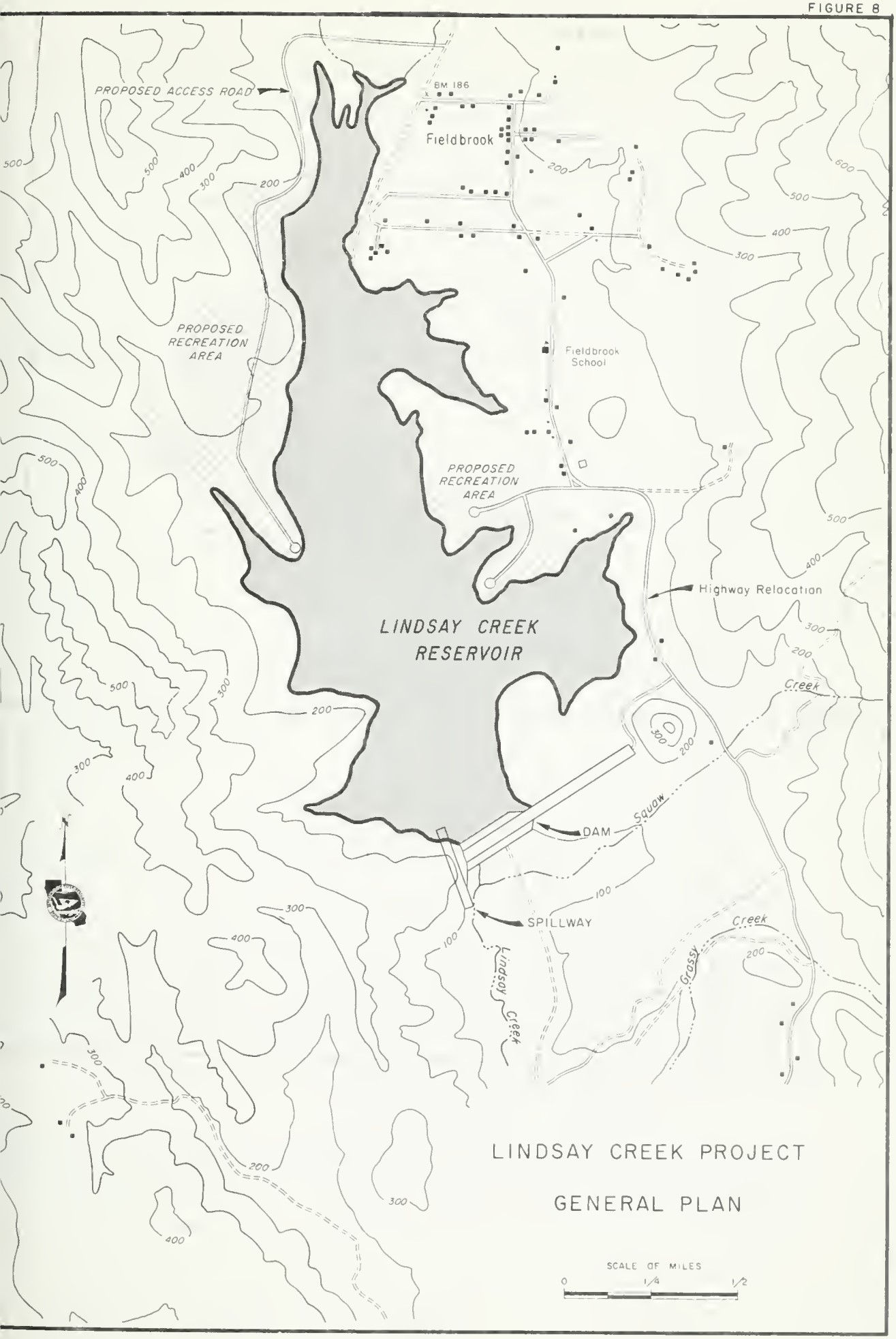

PROPOSED ACCESS ROAD
BM 186
Fieldbrook
PROPOSED RECREATION AREA
Fieldbrook School
PROPOSED RECREATION AREA
Highway Relocation
LINDSAY CREEK RESERVOIR
Creek
DAM
Squaw
SPILLWAY
Creek
Grassy
Lindsay Creek
LINDSAY CREEK PROJECT
GENERAL PLAN
SCALE OF MILES
0
1/4
1/2

TABLE 5

LINDSAY CREEK PROJECT FEATURES

LINDSAY CREEK RESERVOIR

Drainage area, in square miles	10.4
Maximum water surface elevation, in feet	155
Normal water surface elevation, in feet	140
Minimum pool elevation, in feet	90
Capacity, at normal pool elevation, in acre-feet	17,700
Area of water surface at normal pool, in acres	620
Mapping	USGS Arcata North Quadrangle 7.5 minute series

DAM

Location	Section 2, T6N, R1E, HB&M
Type	Zoned Rockfill
Height above streambed, in feet	80
Crest elevation, in feet	160
Volume of fill, in cubic yards	2,160,000

SPILLWAY

Type	Ungated Chute
Design capacity, in cubic feet per second	25,000
Elevation of weir crest, in feet	140
Length of weir crest, in feet	120

OUTLET WORKS

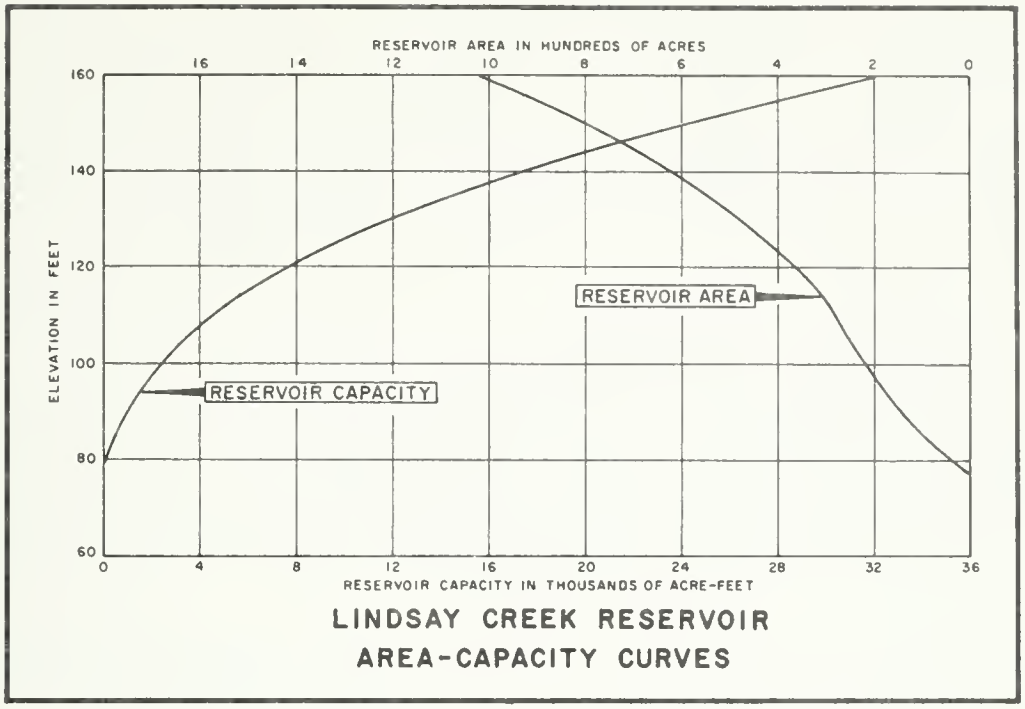
Conduit type	Cut and Cover
Control type	36" Hollow Jet Valve
Type of intake	Uni-level
Energy dissipator	Stilling Basin
Design capacity (minimum pool), in cubic feet per second	200

Lindsay Creek Reservoir

Reservoir sizing is limited by topographic features and the proximity of the reservoir to the community of Fieldbrook. A normal water surface elevation lower than 140 feet would result in decreased recreational use and insufficient capacity to serve the increasing water demands of the Eureka-Arcata area. Increasing the normal water surface elevation above 140 feet would drastically increase the volume of the dam section and would flood prime recreation land and populated areas in the community of Fieldbrook.

A reservoir at this site with a normal pool elevation of 140 feet would have a gross storage capacity of 17,700 acre-feet and a normal water surface area of 620 acres. Reservoir capacity and water surface area at various elevations are shown Figure 9.

FIGURE 9



LINDSAY CREEK RESERVOIR
AREA-CAPACITY CURVES

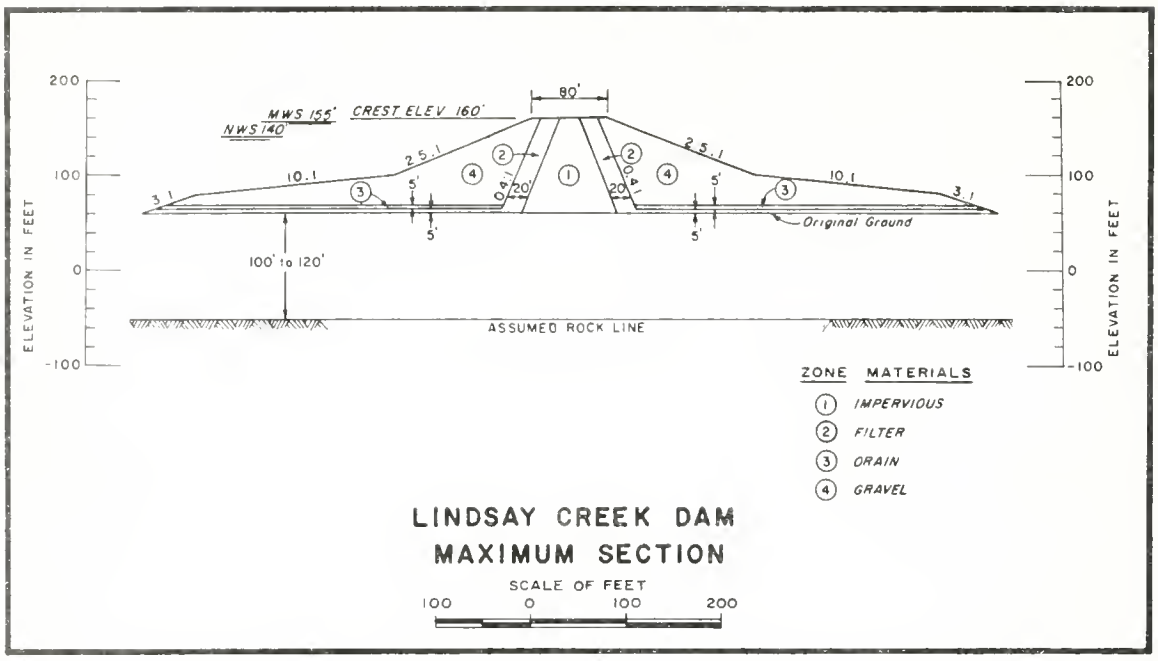
Approximately 1,445 acres of land would need to be acquired for he reservoir and recreation development. The entire reservoir area up to he normal pool elevation of 140 feet would require clearing. Approximately mile of county road would be relocated out of the proposed reservoir.

am

Detailed knowledge of the engineering properties of the foun- ation materials could not be determined within the scope of this study. owever, from the geology information available, foundation conditions ppear to be very poor. The seismic survey made at the site indicates hat bedrock is approximately 100 to 120 feet below ground surface at the am axis. The bedrock is thought to be overlain by a highly compressible, ow-strength clay similar to a bay mud. There are indications of a possible ault zone which may run under the left abutment. However, the fault is pparently not active or unduly hazardous. The dam section selected, and hown in Figure 10, is a type used to compensate for extremely poor foun- ation conditions such as weak soils and prolonged settlement.

The dam would be a gravel shell structure with impervious core nd sand drains to dissipate excessive foundation pore water pressure. lat sloping berms will be necessary outside the normal dam section in rder to restrain the weak foundation material from displacing outward from eneath the axis of the dam. The weight of the dam will probably cause bout 20 feet of settlement in the foundation materials. This settlement ill probably occur over a two-year period. The construction schedule will

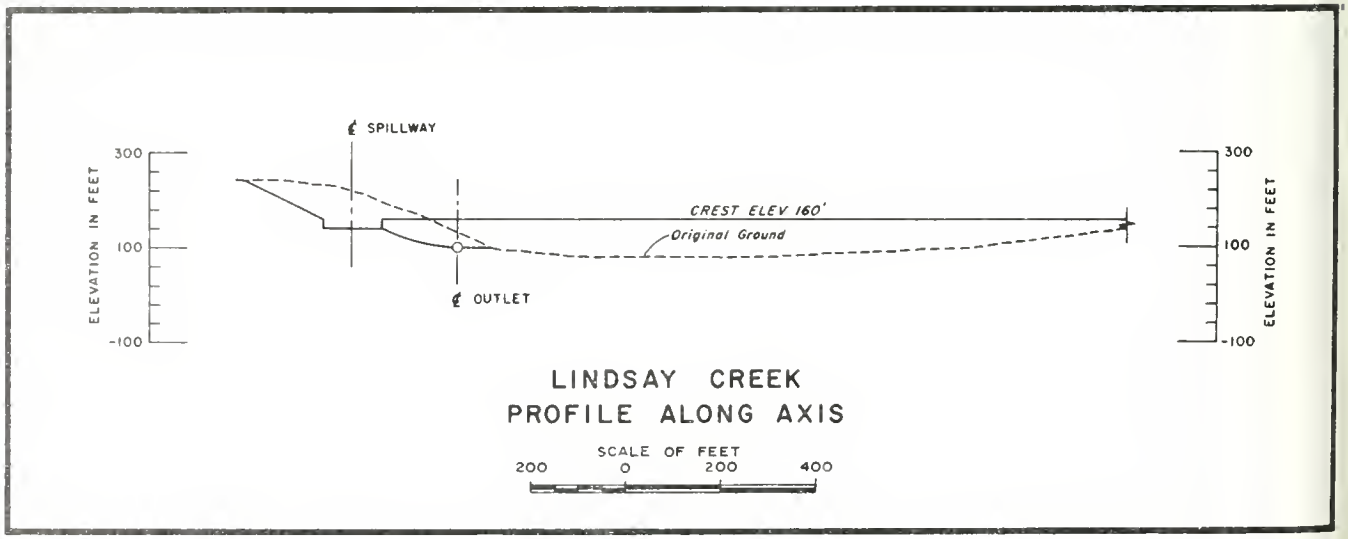
FIGURE 10



be controlled largely by readings from pore pressure measuring devices installed in the foundation. It is estimated that two 5-month construction periods would be adequate; however, a longer schedule could be dictated by excessive foundation pressures.

Total embankment material in the dam would be 2,160,000 cubic yards. The impervious material would be excavated from the terrace upstream from the left abutment. Gravels would be hauled from the Mad River. A profile of the Lindsay Creek Dam axis and spillway is shown in Figure 11.

FIGURE 11



Spillway

A concrete-lined chute spillway would be founded on sandstone at the right dam abutment. Discharge would be controlled by an ogee weir at elevation 140 feet with a crest length of 120 feet. The spillway was designed to pass the estimated probable maximum flood of 25,000 cfs with a maximum surcharge of 15 feet. The spillway would terminate in a stilling basin on the right bank of Lindsay Creek.

Outlet Works

The outlet works was designed to pass 200 cfs with the reservoir at minimum pool. Following construction, the proposed cut-and-cover conduit diversion facilities would be converted to an outlet works. The conduit would be plugged under the dam axis. Releases would be made through a 3-foot-diameter steel pipe imbedded in the conduit plug. A 6-foot slide gate installed on the upstream end of the cut-and-cover conduit would be used for emergency closure of the outlet works.

Recreation Facilities

The area around Lindsay Creek Reservoir is well suited for recreation development. The densely forested lands would require selected clearing for development of recreation facilities. The facilities would be sized to accommodate annually about 115,000 visitor-days initially and about 435,000 visitor-days by the end of the project analysis period. Facilities costs were provided by the Department of Parks and Recreation.

Fishery Preservation and Enhancement

The Lindsay Creek Dam would block about 10 percent of the Mad River silver salmon runs from their spawning grounds. During an average year, 250 silver salmon, 50 king salmon, and 50 steelhead spawn in Lindsay Creek according to the Department of Fish and Game. Mitigation for lost spawning areas can best be accomplished by hatching and rearing salmon and steelhead at the proposed Mad River Hatchery. Trapping facilities below the dam and increased capacity at the hatchery would be provided by the project sponsor.

The Department of Fish and Game estimates that a Lindsay Creek Reservoir of 620 surface acres would produce, naturally, sufficient trout to provide for approximately 3,000 angler-days a year. Hatchery-reared, catchable-sized trout would be required for additional fishing use. The fishing use expected to occur at Lindsay Creek Reservoir increases from 12,000 angler-days in 1975 to an ultimate use of 40,000 angler-days in 2045. The capitalized cost of rearing and planting catchable-size trout during the period from 1975 to 2075 is estimated at $250,000.

Preservation of Wildlife

The area that would be inundated by Lindsay Creek Reservoir supports a variety of wildlife species, such as deer, beaver, valley quail, and waterfowl. The clear land interspersed with woodland, marsh, and stream bottom is rare on the North Coast and represents an ecological type that tends to concentrate wildlife in close contact with urban development. The Department of Fish and Game has recommended that mitigation for the habitat lost be accomplished by developing selected areas of the reservoir shoreline to produce wildlife habitat and by establishing green belt zones on Lindsay Creek and Mather Creek immediately above the reservoir.

Off-site mitigation for lost wildlife habitat is another alternative, particularly since on-site mitigation may be incompatible with recreation development. The Humboldt Bay marshlands are an ecological area supporting a great deal of wildlife, parts of which could be preserved in a natural state in substitution for inundated wildlife areas.

Summary of Project Costs

A summary of the estimated project costs during the 100-year period of analysis (1975-2075) is presented in Table 6. The analysis uses a 4 percent interest rate. The initial investment cost for this project is estimated to be $12,400,000. The capitalized value of all expenditures over the 100-year period of analysis is estimated at $17,250,000. The average annual equivalent cost would be $704,000.

TABLE 6

SUMMARY OF LINDSAY CREEK PROJECT COSTS
(In Dollars)

Project Feature	Present Worth			Average Annual Equivalent Cost
	Investment Cost	Operation 1/ Maintenance, Replacement, and General Expense	Total Capitalized Cost	
Dam, Reservoir, and Appurtenances	11,100,000	500,000	11,600,000	473,400
Recreation Facilities	1,100,000	4,200,000 2/	5,300,000	216,300
Fish and Wildlife Preservation	200,000	150,000	350,000	14,300
Total	12,400,000	4,850,000	17,250,000	704,000

1/ Present worth of future additions and expenditures.
2/ Includes cost of planting catchable trout.

Project Accomplishments and Benefits

Since there are no freshwater recreation reservoirs within the study area, there is a large unfulfilled demand for this type of recreation. However, the opportunity for recreation at most reservoir sites within the study area is seriously restricted due to a lack of developable recreation lands. This is not the case at Lindsay Creek Reservoir. In this drainage the lands along the stream are gently sloping and most of the area around the reservoir would be well suited for recreation development.

The Eureka-Arcata area will soon be in need of new water supplies to supplement the safe annual yield from Ruth Reservoir which is approaching full utilization. The Butler Valley Project is recognized as this area's best long-range future source of water; however, an interim supply may be needed to provide water prior to the construction of this major project.

Lindsay Creek Reservoir could be operated to meet the need for an interim water supply and to provide for much of the water-oriented recreation demand. The best operating schedule with which to satisfy these dual purposes is one which would hold Lindsay Creek near normal water surface elevation while making all water supply releases from Ruth Reservoir. The only time it would be necessary to draw the Lindsay Creek pool down significantly would be during drier periods estimated to occur on the average of 1 year in 10.

Water Supply

In March 1956 the Eureka-Arcata area, and smaller surrounding communities including McKinleyville, formed the Humboldt Bay Municipal Water District. The District completed the construction of Ruth Reservoir in 1962 to supply a safe annual yield of 84,000 acre-feet to the municipal and industrial communities near the mouth of the Mad River. At the present time the water supply from Ruth Reservoir has been contracted for with only 4,000 acre-feet in reserve for future municipal requirements. Additional water supplies must be developed in order to meet the growing requirements of this area.

The Butler Valley Project is recognized as the most promising long-range water supply project to serve the Eureka-Arcata area. For the purpose of this report, it was assumed that the Butler Valley Project would not be constructed until 1985. It now appears that an earlier construction date is likely; however, an earlier completion date would almost certainly preclude the construction of a Lindsay Creek Project as an interim water supply.

The Lindsay Creek Project would increase the safe annual yield at the existing HBMWD Essex diversion from the present level of 84,000 acre-feet to 110,000 acre-feet. Ruth Reservoir alone has the capability of

supplying 110,000 acre-feet 9 years out of 10 but can only supply 84,000 acre-feet during the year of lowest flows. Lindsay Creek flows would be used to supplement Ruth Reservoir flows whenever necessary to maintain a combined safe annual yield of 110,000 acre-feet. This is an increase of 26,000 acre-feet annually available at the Essex diversion.

Future demand estimates by federal, state, and local agencies indicate that the 26,000 acre-feet of yield from the Lindsay Creek Project could be fully utilized by 1980. Using these projections, assuming a 1975 project completion date, a $20 per acre-foot unit benefit which corresponds closely to the current cost of water at the Essex diversion, a 4 percent interest rate, and a 100-year period of analysis, the project would have a total capitalized water supply benefit of $12,600,000.

In this analysis a water supply benefit is attributed to Lindsay Creek Reservoir over the full 100-year economic life of the project even though the Butler Valley Reservoir may be constructed early in this period. If the Lindsay Creek Project is constructed prior to Butler Valley, the initial sizing of the Butler Valley Reservoir water supply reservation should take into consideration the quantity of water then currently available from both Ruth and Lindsay Creek Reservoirs.

Recreation

The Lindsay Creek Valley is a desirable location for a small recreation reservoir. The valley is surrounded by densely forested ranges protecting a meadowed valley floor which supports a variety of vegetation. A reservoir within this setting would appeal to local water sports enthusiasts as well as vacationing tourists seeking a camping or picnicking area. The population within a 25-mile radius includes Eureka, Arcata, McKinleyville, and Blue Lake. Other factors lending to the desirability of recreational use at Lindsay Creek Reservoir are: (1) good access, (2) an abundant amount of land surrounding the reservoir that is well suited for recreational development, (3) a considerable demand for water-oriented recreational opportunities in the area, and (4) project operational criteria that would lead to a very desirable recreation pool during most years. The major limiting factor affecting recreational use at this project will be the relatively cool coastal weather conditions. The average maximum summertime temperature in the Lindsay Creek Valley is approximately 71 degrees.

An estimated 155,000 recreation days of initial use in 1975 will increase to 435,000 by 2075, according to the Department of Parks and Recreation. Table 7 shows the expected recreation use at the Lindsay Creek Project with and without the Butler Valley Project.

The Department of Parks and Recreation has estimated a unit benefit of $1.96 per visitor-day for this project. Assuming the Butler Valley Project will be built, the capitalized value of the recreation benefit at this project is $9,800,000.

TABLE 7

PROJECTED ANNUAL RECREATION USE
AT THE LINDSAY CREEK PROJECT
(In 1000 visitor-days)

Year	Without Butler Valley			With Butler Valley 1/		
	Day Use	Overnight	Total	Day Use	Overnight	Total
1975	90	25	115	90	25	115
1985	135	35	170	125	35	160
1995	190	50	240	145	50	195
2005	260	75	335	155	75	230
2015	325	95	420	170	95	265
2025	350	100	450	190	100	290
2035	350	100	450	215	100	315
2045	350	100	450	245	100	345
2055	350	100	450	275	100	375
2065	350	100	450	305	100	405
2075	350	100	450	335	100	435

1/ Assuming 1985 construction.

Summary of Project Benefits

A summary of estimated total project benefits is presented in Table 8. The total capitalized value of the benefits is $22,400,000; the average annual equivalent value is $914,000.

TABLE 8

SUMMARY OF LINDSAY CREEK PROJECT BENEFITS
(In dollars)

Project Purposes	Capitalized Benefits	Average Annual Equivalent Benefits
Water Conservation	12,600,000	514,000
Recreation	9,800,000	400,000
Total	22,400,000	914,000

Economic Justification

The present worth of the project benefits attained throughout the period of economic analysis (1975-2075) was estimated at $22,400,000. The

total capitalized cost of the project, including the present worth of all future expenditures, was estimated at $17,250,000. The resultant benefit-cost ratio is approximately 1.3:1. The Lindsay Creek Project is economically justified and, if constructed in 1975, would produce net benefits (benefits minus costs) of about $5,150,000.

Cost Allocation

A preliminary allocation of project costs was made to determine the share of the total project costs that would be assigned to each of the project purposes. The allocation, using the separable cost remaining benefit method, is presented in Table 9.

TABLE 9

PRELIMINARY COST ALLOCATION
FOR THE LINDSAY CREEK PROJECT
(In average annual equivalent dollars)

	Water Conservation	Recreation	Total
Benefits	514,000	400,000	914,000
Alternative Costs	306,000	1/	---
Justifiable Costs	306,000	400,000	706,000
Separable Costs	41,000	204,000	245,000
Remaining Justifiable Costs	265,000	196,000	461,000
Percent Distribution	57.5%	42.5%	100%
Remaining Joint Costs	264,000	195,000	459,000
Total Allocated Costs	305,000	399,000	704,000

1/ Assumed to exceed benefits.

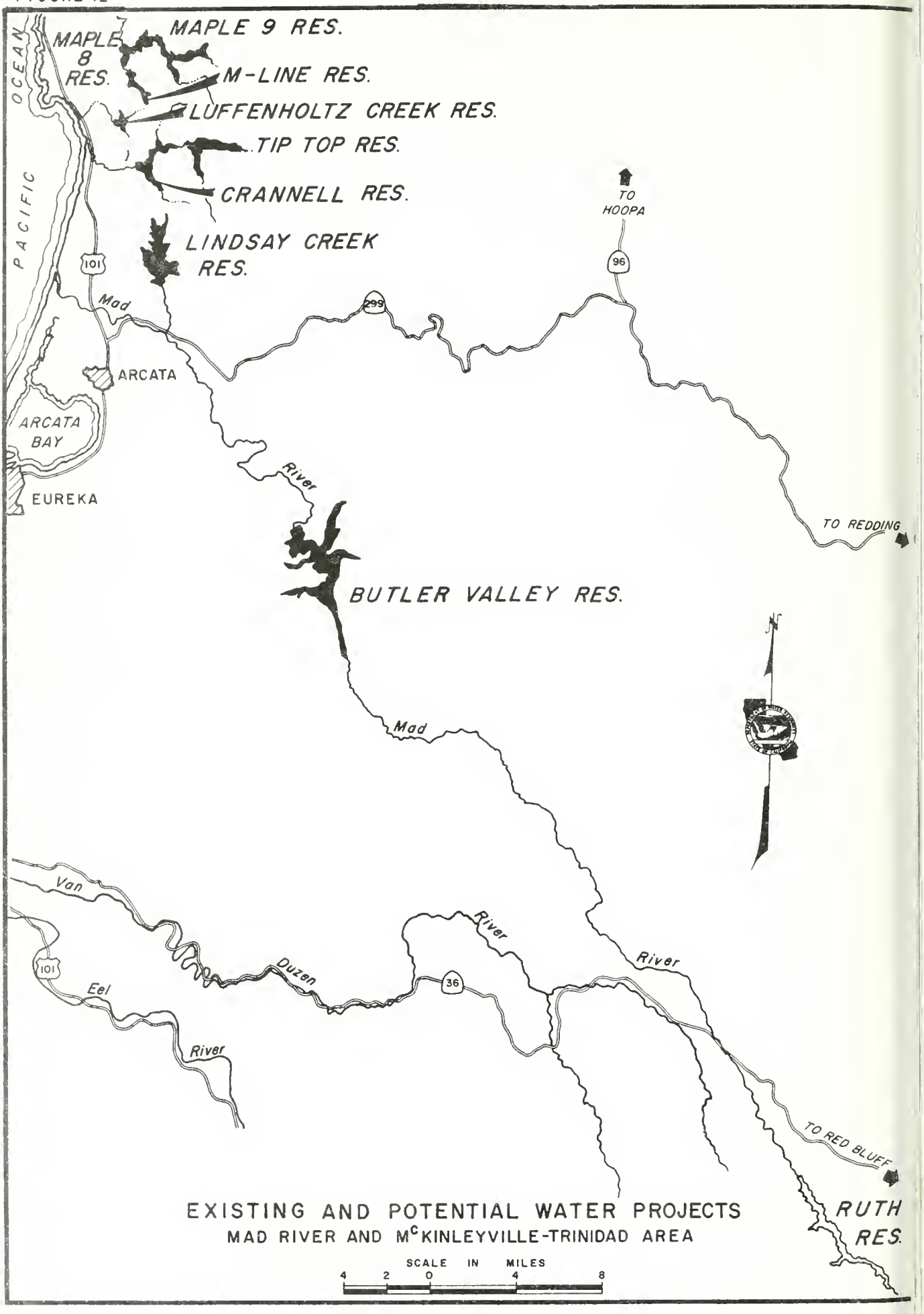
This sharing of costs would result in a unit water cost of about $11.50 per acre-foot at the reservoir. Even with the additional costs for diversion, transmission, distribution, and treatment, a reasonable and competitive household charge for domestic water could result.

Implementation of the Lindsay Creek Project

The Lindsay Creek Project is proposed as a potential source of additional water supply for the HBMWD and as a recreation reservoir capable of serving 450,000 visitor-days annually. Even though the Butler Valley

Project is recognized as the best long-term source of water to the District, it may be desirable to construct the Lindsay Creek Project to serve the incremental needs of the area until the larger projected demands of the Eureka-Arcata area materialize. The HBMWD has been studying a project on Little River as a similar alternative to Lindsay Creek. The District must decide if it is expedient to construct a smaller-scale project prior to Butler Valley.

FIGURE 12


MAPLE 9 RES.
MAPLE 8 RES.
M-LINE RES.
LUFFENHOLTZ CREEK RES.
TIP TOP RES.
CRANNELL RES.
LINDSAY CREEK RES.
OCEAN
PACIFIC
101
Mad
299
TO HOOPA
96
ARCATA
ARCATA BAY
EUREKA
River
TO REDDING
BUTLER VALLEY RES.
Mad
Van
Duzen
River
River
Eel
River
101
36
TO RED BLUFF
RUTH RES.
EXISTING AND POTENTIAL WATER PROJECTS
MAD RIVER AND McKINLEYVILLE-TRINIDAD AREA
SCALE IN MILES
4 2 0 4 8

CHAPTER 5. OTHER PROJECTS CONSIDERED

During this investigation the Department considered several projects other than Lindsay Creek and M-Line. Also, other agencies and individuals have conducted planning studies seeking solutions to water problems of the Eureka-Trinidad area. This chapter briefly summarizes these other planning efforts. The various projects which have been studied are shown in Figure 12.

The Butler Valley Project

A water supply project at the Butler Valley site was identified in Department Bulletin No. 3, "The California Water Plan", and mentioned as a potential replacement to Ruth Reservoir in Bulletin No. 136, "North Coastal Area Investigation". The U. S. Army Crops of Engineers in their recent report on the Mad River Basin has recommended construction of the Butler Valley Project for flood control, water supply, and recreation. The Corps has found that by constructing a rockfill dam 350 feet high and creating a multiple-purpose 460,000 acre-foot reservoir, practically all flood damage downstream from the dam can be eliminated, a firm supplemental water supply yield of 160,000 acre-feet can be developed, and the fresh-water recreation demands of the region can be met for many years. The findings concerning the Butler Valley Project were revealed at a public meeting held by the Corps of Engineers in Eureka on November 10, 1967.

The Butler Valley Project received Congressional authorization in August 1968, through the passage of the Omnibus Rivers, Harbors, and Flood Control Act. Authorization permits allocation of funds for advanced engineering and design. The project has the endorsement of the Humboldt Bay Municipal Water District, Humboldt County, and the State of California. The Butler Valley Project is widely viewed as the most desirable long-term solution for the increasing water needs of the Humboldt Bay and allied areas. The project could easily serve the combined needs of the HBMWD and the McKinleyville-Trinidad area.

Tri-Lake Plan

The Tri-Lake Plan is the outgrowth of a compromise Regional Redwood Park Plan presented by Dr. Rudolph W. Becking, a Humboldt State College forestry professor, before the Congressional Committee on Interior and Insular Affairs, in Washington, D. C. The plan envisions sizable lakes on Maple Creek, Little River, and Lindsay Creek for the multipurpose uses of recreation, water supply, and fish enhancement. The U. S. Army Corps of Engineers accepted a joint request from the city councils of Eureka and Arcata to investigate the "Tri-Lake Proposal" in their studies of the Butler Valley Project. As a result of their study it was concluded that

the Tri-Lake Complex does not constitute the best overall plan of development when compared with other alternatives, and that additional studies of the plan are not warranted. However, the HBMWD studies of Crannell Reservoir on Little River, and our studies of Lindsay Creek, incorporate many features of the Tri-Lake proposal.

Maple Creek Basin

The Department of Water Resources studied projects on Maple Creek during investigations for this report. Maple Creek, with an estimated mean annual runoff of 110,000 acre-feet, appears to offer an attractive source of new water to the study area. However, the remoteness of projects on this stream would require costly conveyance works and the large flow required for fishery maintenance greatly reduces the potential yield of the Maple Creek projects.

Three storage sites (see Figure 12) in the Maple Creek drainage basin were studied during this investigation. They are Maple 8 and Maple 9 on the main stem of the creek and M-Line damsite on a small tributary, M-Line Creek. The M-Line Project was discussed in Chapter 3. Maple 8 and Maple 9 were sized to serve the entire McKinleyville-Trinidad area while M-Line would serve only the needs of the Trinidad-Moonstone area.

Recreation potential on both Maple Creek sites is limited by steep terrain. Approximately 60 acres of suitable recreational area is available at either reservoir site.

Water treatment including iron removal, chlorination, and filtration was assumed for both Maple Creek projects.

Maple 8

This damsite lies just below the confluence of Maple and M-Line Creeks in the approximate center of Section 8, T8N, R1E, HB&M. A 105-foot dam would impound 5,000 acre-feet of water at a normal water surface elevation of 520 feet, covering an area of 130 acres. The dam would require approximately 300,000 cubic yards of embankment material.

Transmission of water from this reservoir to the service area could be effected through several different schemes. For our evaluation of both Maple Creek damsites we assumed water would be pumped from either reservoir through the saddle of the south line of Section 17 to a treatment plant near the Crannell-Big Lagoon logging road. From here it would be piped west to a terminal storage tank above Trinidad and south to tanks at various locations.

Maple 9

The Maple 9 damsite is located upstream from Maple 8 in the northern half of Section 9, T8N, R1E, HB&M. A 90-foot-high dam would impound 5,000 acre-feet of water at a normal water surface elevation of

50 feet, covering an area of 220 acres. An embankment volume of approxiately 200,000 cubic yards would be necessary to form the dam. Due rimarily to the smaller embankment volume required, this dam would be ess expensive than Maple 8.

Little River Basin

The Little River drainage basin, with a mean annual runoff of 3,600 acre-feet at the Crannell gaging station, is a centrally located vailable source of water. Two water conservation projects, Crannell and ip Top, were examined and found to be promising alternatives for new ater to the McKinleyville-Trinidad area. A dam and reservoir at the rannell site was presented in Department Bulletin No. 3 as a potential omestic and industrial supply to the Eureka-Arcata area. The Tip Top ite was listed in Department Bulletin No. 136 as a possible location for coastal stream fisheries enhancement project.

The Department studied developments at both of these sites ized to supply the needs of the McKinleyville-Trinidad area only. After hese evaluations were completed, the HBMWD decided to study expanded evelopments at these sites that would be sized to include water supply o the Eureka-Arcata area as well as the McKinleyville-Trinidad area.

Both Crannell and Tip Top damsites would block several miles of xisting spawning gravels and rearing areas to anadromous fish. To miti-ate for this damage, a fish hatchery would need to be built as a part of ither project.

rannell Dam Site

This damsite is located in the northeast quarter of Section 9, 7N, R1E, HB&M, less than a mile east of the community of Crannell. A 05-foot-high dam would impound 5,000 acre-feet of water at a normal water urface elevation of 175 feet, covering an area of 130 acres. The reser-oir in our study was sized at 5,000 acre-feet to serve only the cKinleyville-Trinidad service area. Because of generally steep terrain urrounding the reservoir, only about 30 acres of suitable recreation land s available for development.

Water would be released from the reservoir to a pumping and reatment plant downstream from the town of Crannell. From this plant, ater would be carried to north and south service areas through a pipeline.

ip Top Dam Site

This damsite is located on Little River approximately 3 miles east f Crannell community in the SW$\frac{1}{4}$ of Section 35, T8N, R1E, HB&M. A 70-foot-igh dam at this location would impound 5,000 acre-feet of water at a normal ater surface elevation of 300 feet, covering an area of 230 acres. There

are only about 45 acres of land near the reservoir suitable for recreation development. Water would be treated and distributed through the same plan as proposed with Crannell.

Humboldt Bay Municipal Water District Studies on Little River

A July 1968 report prepared for the Humboldt Bay Municipal Water District, entitled "Feasibility of Developing Supplemental Water Supply from Little River for Humboldt Bay Municipal Water District", presents the eighteen general findings and recommendations. Included among these are:

1. "The Humboldt Bay Municipal Water District faces a need to supplement existing water supply facilities to sustain growth in the Humboldt Bay area. At the present time 71 of the 75 MGD firm yield capacity of Ruth Dam on Mad River has been committed by contractual agreement for municipal and industrial water supply. The projected requirements of the Humboldt Bay area during the decade of 1970-80 indicate an increase for industrial water of 60 MGD and for domestic water of 3.5 MGD. The long range projections of water requirements indicates a total need far in excess of 100 MGD of additional water. It is anticipated that Butler Valley Dam will provide for the long range growth in water requirements for the area and the District has agreed to participate with the Corps of Engineers in its construction and utilize the water that it would provide. However, the earliest that Butler Valley Dam could be operational is about 1973 and it is more probable that it will be completed at a considerably later date.

"An action plan for a supplemental water supply of a scope within the District's funding ability is a necessity, in the event of either accelerated water demands or delay in construction of the Butler Valley project. In this context, development of a supplemental water supply from an enlarged Ruth Dam or Little River is feasible and attractive."

* * *

4. "A dam at Crannell is preferred to one at Tiptop as it would provide a more economical source of water.

5. "Maximum benefits from the Crannell project can be realized by construction of a large dam and reservoir and integrating the use of water stored in Little River with Mad River excess winter flows so as to increase the available capacity of the supplemental water project."

* * *

11. "The estimated cost of the Crannell project, disregarding hydroelectric development, for a firm yield of 36 MGD based on current construction costs would be:

Dam and Appurtenances	$	10,050,000
Diversion Transmission, Treatment and Accessory Features		6,050,000
TOTAL	$	16,100,000

* * *

16. "It is recommended that the Humboldt Bay Municipal Water District should further investigate what State and Federal grant funds would be available to provide a portion of the costs of water development on Little River.

17. "It is recommended that further effort be exerted by the Humboldt Bay Municipal Water District with the California Department of Fish and Game in an effort to secure a more realistic appraisal of fisheries in Little River and the consequential requirement for fish release and fish mitigation as a reduction in fish flows could substantially reduce project and water costs.

18. "It is recommended that the Humboldt Bay Municipal Water District keep informed of the progress and obtain a definite schedule of the development program for Butler Valley Dam. At the same time, periodic review of the interim water needs of the Humboldt Bay area should be made in order to ascertain the necessity of a supplemental water project. Detailed investigation of geologic and engineering features of the Little River or Ruth Dam enlargement projects should proceed in order that construction could be expedited in the event that a delay in the construction of the Butler Valley Dam becomes apparent."

Luffenholtz Creek Development

The upper reach of Luffenholtz Creek offers some potential for small-scale water supply development sufficient to serve the Trinidad-Moonstone area. The Luffenholtz damsite is located near the center of Section 29, T8N, R1E, HB&M, on the South Fork of Luffenholtz Creek. A 105-foot dam would impound 1,000 acre-feet of water at a normal pool elevation of 175 feet, covering an area of 40 acres. A dam at this location would be more costly per acre-foot of storage than any other site studied.

A study for the city of Trinidad by Winzler and Kelly, consulting engineers, suggests the possibility of utilizing the natural flows of Luffenholtz Creek near its mouth to serve the Trinidad-Moonstone area. The workability of such a plan is dependent upon the magnitude and duration of the minimum summer and fall flows of Luffenholtz Creek. Little was known of the low-flow hydrology of Luffenholtz Creek until the summer and fall of 1968 when a stream stage recorder was installed and operated by the Department. Results from this recorder through July, August, and September following a relatively dry winter season indicate an adequate sustained summer flow to serve the projected water needs of the Trinidad-Moonstone area until approximately 1990. However, a single summer is not an adequate time period in which to reliably establish the low-flow characteristics of a stream. This recording gage will continue to be operated during the dry months of at least another year.

Lower Lindsay Creek Alternatives

In studying the Lindsay Creek Valley as a potential reservoir site, three damsites were originally considered as alternatives (see Figure 7). The two lower sites are located near the mouth of Lindsay Creek between Essex Pond and the Mad River. The southernmost alternative is in the narrow valley section immediately south of the State Route 299 bridge crossing Lindsay Creek. A dam at this seemingly ideal location would be subjected to erosion by the high flows of the Mad River. Also, construction of a dam at this site would necessitate a costly relocation of the portion of State Route 299 which traverses the damsite. The second lower valley alternative damsite is located between Essex Pond and existin State Route 299. A dam at this site would be 60 feet high and would have a crest length of 2000 feet. The main advantages of a lower valley damsite are increased potential reservoir capacity and greater runoff available to the reservoir.

The northernmost damsite, located above Squaw Creek and presente in Chapter 4, was chosen as the most desirable of the three alternative damsites for the following reasons. The upper valley reservoir is superic from a recreational standpoint. Much land of a gently sloping, heavily timbered nature is available immediately surrounding the upper reservoir and is readily adaptable to camping, picnicking, and hiking use. A lower valley reservoir with a normal water surface elevation of approximately 100 feet would inundate many homes along lower Fieldbrook Road. A lower valley reservoir would have the undesirable characteristic of leaving exposed a large area of extremely flat reservoir bottom land when the wate surface elevation drops during the summer months. This area is located at the northern end of the reservoir and would in effect be wasted land unsuitable for most purposes. A damsite on lower Lindsay Creek would block all anadromous fish from their spawning and rearing gravels in the drainage, and would flood 58 percent of the valley-type wildlife habitat.

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